# NOVA/BEAMLET/NIF UPDATES OCTOBER–DECEMBER 1996

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## Nova Operations

During this quarter, Nova Operations fired a total of 176 system shots resulting in 205 experiments. These experiments were distributed among ICF experiments, Defense Sciences experiments, X-Ray Laser experiments, Laser Sciences, and facility maintenance shots.

Smoothing by spectral dispersion (SSD) on all 10 beamlines of Nova was activated during this quarter. In addition to the activation of the SSD system in the preamp section of the laser, this change also included the installation of double debris-shield holders on all focus lens assemblies of the 10-beam chamber. The double debris-shield holders contain both the kinoform phase plates (KPPs) and a debris shield to protect them from target debris resulting from a shot. Activation required several days of beam propagation evaluation and system performance verification. The application of SSD and KPPs produces an improvement in spatial smoothness of the focal spot on target.

We have started the installation of the 4ω probe beam for the 10-beam target chamber. This beamline will be created by a "pick-off" mirror installed into the center obstruction of beamline 8 in the switchyard. This subaperture, 1ω beam will be propagated to the 10-beam chamber where it will be converted to 4ω and used as a target diagnostic probe beam. Installation will continue through this quarter, with system activation scheduled for next quarter.

The Los Alamos Full Aperture Back Scatter Imager was installed on beamline 7 in the target area. The primary purpose of this instrument is to provide time-resolved target-plane images of the stimulated Raman (SRS) and stimulated Brillouin (SBS) backscatter emission. In addition, the instrument will measure the energy and time-integrated near-field pattern of the SRS and SBS backscattered light.

In continuing support of the Petawatt project, the Petawatt minichamber was received and is being cleaned and prepared for installation in January of 1997. This minichamber will be used during the initial Petawatt demonstration to measure system performance and beam focusability. The 32-in. gate valve between the compressor chamber and the minichamber was installed. The fabrication of the parabolic mirror system vacuum housing, extension tube, and gimbal rings by Bechtel Nevada was completed and received. The parabolic mirror is due in early February of 1997. The details of the Target Alignment Viewer and Target Inserter have been completed, and fabrication of these systems has started. The backscatter diagnostic table and enclosure were also installed. These systems will be installed and activated on the minichamber late next quarter.

Tests comparing the performance of a Princeton Instruments charge-coupled device (CCD) camera to film was completed. The results show that the CCDs compare favorably with film. The details of this evaluation are being compiled, and a report will soon be available. Further comparisons of CCDs and film coupled to a microchannel plate on an x-ray source are continuing.

We have started planning for the decommissioning of the Nova Two-Beam Target Area. The hardware in this area will be disassembled and removed for salvage or storage as appropriate. Experiments in the Two-Beam area will end in September of 1997. The area must be clear for activation of the National Ignition Facility (NIF) optics processing facility by mid-December of 1997.

# Beamlet

Beamlet continues to provide the test bed to validate the laser physics foundations of the National Ignition Facility (NIF) and to check laser engineering concepts and components proposed for the NIF. During the first quarter of FY 1997, activities on Beamlet included the following:

1. Reactivation of the laser following the lens implosion caused by side-scattered stimulated Brillouin scattering (SBS) during the long-pulse campaign in September of 1996.
2. Installation and activation of beam smoothing by one-dimensional smoothing by spectral dispersion (1-D SSD) on the Beamlet preamplifier.
3. Initial detailed beam-quality characterization of the injected near field.
4. Installation and alignment of NIF prototype square spatial filter lenses.
5. Recalibration of existing wavefront sensors and installation of additional higher-resolution sensors in preparation for detailed wavefront characterization shots, planned for January 1997.

The prevention of vacuum barrier optics damage and implosion is critical for the NIF design. Analysis of failed lenses has shown that a significant reduction of the internal stress can prevent formation of multiple cracks, in addition to increasing the critical flaw size. Modifications were completed to install tilted square lenses in all Beamlet spatial filters. These have a stress significantly lower than the original round lenses, and are comparable to Nova spatial filter lenses (<900 psi). The tilted lens design required a complex alignment procedure to maintain the overall static aberration below two waves peak-to-valley.

An operational readiness review and fault analysis were completed before reactivating the laser. Several measures were implemented to reduce the SBS sidescatter risk, including real-time bandwidth sensors for the master oscillator room and regenerative amplifier. An optical fail-safe system is being designed and tested, and will be installed in the Beamlet Master Oscillator later in FY 1997, complementing the existing electronic fail-safe system.

While system reactivation activities took place on the main laser, several campaigns were completed to characterize the Beamlet injection beam. This information is required to complete the Beamlet propagation model and noise analysis by the NIF Project. Near-field measurements were performed using an additional diagnostic system and confirmed a contrast level of 5%, consistent with model predictions of Beamlet output noise level and preamplifier modeling.

Beam smoothing is an important requirement to optimize target irradiation on the NIF, and Beamlet will test the proposed scheme using 3- to 5-Å bandwidth, critically dispersed in one axis using a grating in the preamplifier (1-D SSD). A first step towards this test was the installation of the preamplifier dispersive optical system and a verification of its operation at the injection plane. Near-field, far-field, and time-resolved power measurements confirmed predicted behavior. Speckle smoothing was tested with a small phase plate in the test setup.

# National Ignition Facility

The principal activity for the NIF Project during this quarter was the completion of the Title I Review process, which included the Independent Cost Estimate (ICE). The Title I Design Review (i.e., for Preliminary Design) was completed November 22, 1996. No issues were identified by the review committee that would preclude starting Title II Design (i.e., Final Design) and long-lead procurements. The ICE Review draft report was completed as scheduled on December 6, with overall estimates in excellent agreement (within about 1%) with the project estimate. The Project requested and DOE/OAK granted approval to initiate Title II design and long-lead procurements. Title II design and long-lead procurements are underway, and progress has been made in all areas.

## Title I Design Review

The Title I Design Reviews were completed in accordance with the *NIF Title I Review Plan*. Formal presentations were made by the Project to the Review Committee consisting of external and internal reviewers with significant expertise in their areas of review.

The review was divided into these main areas:

- Conventional Facilities.
- Optical Design and Laser Performance.
- Laser System.
- Beam Transport System.
- System Control.
- Target Experimental System.
- Optical Components.
- Operations Engineering.
- Integrated Computer Control System.
- The Conventional Facilities Design Review covered the site improvements, Laser and Target Area Building (LTAB), and OAB. Based upon the presentations and the review of numerous design documents provided, the committee submitted extensive comments. While there were numerous important findings, the Committee determined that the NIF Conventional Facilities Title I Design meets the system requirements and is the minimum platform to meet the NIF functional requirements. The

Committee recommended proceeding to Title II design.
- The Laser System reviews included the amplifier, Plasma Electrode Pockels Cell (PEPC), power conditioning, and auxiliary subsystems. Three areas of concern (optical pulse generation, pulse-power switch, and amplifier blast shield/seal) were identified by the Review Committee as requiring management attention early in Title II Design.

The majority of the Title I Design reviews turned up no significant items to resolve before Title II. Following the review, the summary recommendation of the Review Team was "to accept the designs with comment, and proceed with Title II Design." Title II Design started following DOE/OAK approval. There are, however, three areas of concern (optical pulse generation, pulse power switch, and amplifier) that will be addressed in initial Title II Design. As each area of the Project completed its Title I Review, the engineering effort in that area switched to Title II Design.

Based on the Title I Design Review, the *Primary Criteria and Functional Requirements* (PC/FR) for Title II and the *Project Data Sheet* were updated and approved by the Level 1 Baseline Change Control Board (BCCB1) in Washington, D.C. An update of the Title II design criteria based on Title I Design Review results was completed and incorporated in two proposed Baseline Change considerations: (1) Title I update of *Primary Criteria and Functional Requirements* (BCP97-001) and (2) *Project Data Sheet* update (BCP97-002). These proposals were approved by the BCCB1 on December 20, 1996. The *Project Data Sheet* update was submitted to the Secretary of Energy for consideration.

The Title I planning included an accelerated transition to operations in support of the user community. The Title I schedule and planning define the basic strategy for the NIF Project and the ICF Program to implement a smooth transition between construction and operations to support Defense Programs' Stockpile Stewardship and Management Program (SSMP).

## Other Activities

In the Beam Transport System, the design was modified to reflect an optimized 48-PAM structure (not to preclude 96 units). In collaboration with Conventional Facilities, the height of the switchyard concrete building was decreased by 2.5 ft from the Title I design as a cost saving measure. The switchyard space-frame column and mirror-support locations were revised, and dynamic analysis verified that the stability meets specification. Analyses have been completed to support a change to increase the spatial filter lens thickness, thereby reducing the lens stress to 500 psi (from 700 psi) in order to provide an increased safety margin.

In reworking the Preamplifier System for the new 48-PAM design, the functions and design specifications for the splitter section of the Preamplifier Beam Transport System (PABTS) were refined. (The reduction in number of PAMs necessitates a beam-splitter section to inject light from 48 PAMs into 192 beams.) Specifically, the requirements for optical-path-length adjustability and energy-splitting adjustability were developed further based on comments from the Title I review. In addition, the merits of splitting a single PAM's output into a single quad were evaluated.

Significant advances were made in preparation for the Conventional Facilities construction:
- The Project Labor Agreement with national, state, and local labor unions that reduces schedule risks and cost impacts due to potential labor disputes during Conventional Facilities construction was finalized by the Parsons negotiators. The agreement has been signed by the Union Representatives and is awaiting Project Office approval.
- The Owner-Controlled Insurance Program has been approved. This initiative reduces conventional facility construction bid costs and improves site construction safety.
- An updated, integrated schedule for Conventional Facilities construction packages was prepared and distributed. The Conventional Facilities construction management plan was developed.
- The Title II design for the first construction package, Site Preparation, is nearing completion and is on schedule for completion to meet the project milestones leading to the beginning of Site Preparation on March 11, 1997.

During this quarter significant progress has also been made in various areas of the Core Science and Technology (CS&T) Program, which supports the NIF Project:
- Selected design details of the 40-cm deformable mirror are being reevaluated following experience gained from assembly and testing of a full-scale prototype mirror built in the CS&T Program. In particular, it may be possible to simplify the method of attachment of the actuator assemblies on the back side of the substrate.
- The 4 × 2 NIF prototype amplifier activation in AMPLAB has made good progress.
- Assembly of a NIF prototype 2 × 1 PEPC was completed in collaboration with CS&T, and testing started. This unit validates most of the important design features in the NIF design, including a two-aperture-long plasma charging two crystals in parallel; validation of anodized Al as a PEPC housing; and integration of vacuum and electrical interfaces at the end of the 2 × 1 PEPC, thereby

allowing close-packing of PEPC Line Replaceable Units (LRUs) in the NIF.

Advances in power conditioning development included the following:

- In collaboration with CS&T, half-current (250-kA) testing of the ST-300 spark gap switch was completed, and full-current testing began. Flashlamp triggering tests at American Control Engineering validated the flashlamp triggering strategy for the NIF pulse-power system.
- A NIF prototype power conditioning module operated (SNL-Albuquerque) for over 400 shots at full specified voltage and current (25 kV, 500 kA).
- A spark-gap switch was operated (SNL-Albuquerque) for 100 shots. The measured resistance was higher than expected. Reduced delivered energy (~5%) will be addressed if the measurements are validated.
- Power conditioning system testing is continuing at American Controls Engineering. Reliable triggering of flashlamps was demonstrated at a favorable 12 kV, which is one-half the specified voltage.

Permitting and assurance activities included the following:

- The Record of Decision (ROD) for the *Programmatic Environmental Impact Statement on Stockpile Stewardship and Management* was published by DOE on December 11, 1996, establishing LLNL as the NIF site. The ROD was a critical-path constraint on start of construction, procurement, environmental permits, and Critical Decision 3.
- Environmental permit applications were completed and submitted to the regulatory agencies following release of the ROD. These permits are required prior to the beginning of site preparation.
- A significant effort was directed to complete the draft of the *Construction Safety Program* document, which is the overall safety document for construction and special equipment subcontractors and Laboratory personnel at the LLNL site. The activity involves Conventional Facilities, Hazards Control, and Project Assurances.
- The second Public ES&H Working Group meeting was held on October 7, 1996. The briefing included seismic design, decontamination and decommissioning for Nova and NIF, and bounding accidents.

Optics activities included the following:

- The first full-scale NIF crystals were obtained from a rapid-growth KDP crystal. The two 41-cm *Z* plates met the NIF transmitted-wavefront specification. Witness samples from the crystal met the 1ω damage requirement. A photothermal deflection technique as a diagnostic for precursor to KDP bulk damage was demonstrated.
- Two out of four full-sized mirror substrates were manufactured to NIF specifications using the NIF manufacturing process. Coated mirrors will be demonstrated on Beamlet in 3Q FY97. Also, spatial filter lenses that meet NIF power-spectral-density and roughness specifications were manufactured using NIF processes.
- The large-aperture optics drawing package (80 drawings in total) was delivered to the NIF Optics Production group for use in their preparation for long-lead optics procurements. These drawings, which were developed to a near-Title II level of completeness and detail, contain near-final specification information for procurement of the over 7,000 large optical components in the NIF.